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and the splendid investigations of Thuret and Bornet, has almost wholly altered the classification of the sub-class." Four orders are recognized, based upon the development of the cystocarp; the *Menalinaceæ*, *Gagartinaceæ*, *Rhodomenaceæ*, *Cryptonemiaceæ*. The *Bungiaceæ*, including *Perphyra*, are placed at the end of the *Rhodophyceæ* as an *Anhang*. In the last ten pages the *Cyanophyceæ* are briefly treated under two orders, the *Nostocaceæ* and *Clerocaccaceæ*. Throughout the work each order and in the larger orders each family is synoptically treated under four heads; general character, thallus, reproduction and geographical distribution. In it are embodied the results of the latest investigation on all groups, much having been taken from the able investigations of the author and his associates. Errors are comparatively few, one of the most noticeable being the mentioning of genus *Eggregia* as one of the *Fucaceæ* (P. 55). It is again mentioned in its proper place among the *Laminariaceæ* (P. 85).

DE ALTON SAUNDERS.

Taxonomy of the Crinoids.—The true position of a science in the scale of progress is measured by the degree of perfection exhibited in the systematic arrangement of the phenomena of which it treats. Its claims to philosophic recognition are proportional to the accuracy of the genetic relationships shown in its system of classification. If this be true of a general science, it is no less a reality in its various departments. There is, perhaps, nowhere a better exemplification than the Crinoids; and no zoological group has made in recent years more rapid progress towards a rational classification.

The data upon which the systematic arrangement of the stemmed echinoderms rests are elaborately set forth in the lately issued work of Messrs. Charles Wachsmuth and Frank Springer.² It is of great interest to know that the advancement in an understanding of the group has been almost wholly from the paleontological side and that the results are accepted practically without change by the most eminent students of the living forms. As is well known, the crinoids are to-day almost extinct; but that in past geological ages they were the most prolific forms of life. On account of the peculiar construction, unusually great opportunities are afforded for the solution of morphological problems, and full advantage has been taken. Upon so firm a foundation does the classification of the crinoids, as prepared by Wachsmuth and Springer now rest, that it is hardly probable that it will require radical change for a century to come.

² North American Fossil Crinoidea Camerata: Memoirs Museum Comp. Zool., 2 parts, 800 pp., and atlas of 83 plates. Cambridge, 1895.

As regards the major subdivisions of the stemmed echinoderms three groups are recognized: the cystids, the blastoids, and the crinoids. These are considered as groups of equal rank. The forms of the first are earliest in time, lowest in taxonomic position, and are regarded as the ancestral types of the other two. The crinoid type itself is a very old one, dating from the Cambrian in which it is even then in a high stage of development. During the Ordovician the cystidian features had almost wholly disappeared. The crinoidal group is remarkable for the persistence it has shown in preserving its pentamerous symmetry; and although the introduction of the anal plate so disturbed it as to well nigh produce a permanent bilateral arrangement, the former was finally permanently retained.

Neocrinoidea and Palæocrinoidea, the two primary groups of crinoids which were formerly almost universally recognized, are abandoned. In their stead are recognized three principal subdivisions: Inadunata, Camerata and Articulata. It is quite remarkable that this ternate grouping of the crinoids is essentially the same as Wachsmuth originally proposed more than twenty years ago, and that often being compelled by students of the recent forms to abandon it and to substitute others, a careful survey in the light of recent discoveries of all crinoids both fossil and living has clearly shown that the main subdivisions first suggested are essentially valid and are applicable to all known forms. The criteria for separating the crinoids into orders are briefly as follows:

1. Condition of arms, whether free above the radials or partly incorporated in the calyx.
2. Mode of union between plates of the calyx, whether movable or rigid.
3. Growth of stem, whether new plates are formed beneath the proximal ring of the calyx or beneath the top stem joint.

The simplest forms, the Crinoidea Inadunata, have the dorsal cup composed invariably of only two circlets of plates or three where infra-basals are present; there are no supplementary ossicles except an anal piece, which is, however, not always present; the arms are free from the radials up. In the construction of the ventral disk two different plans are recognizable, and upon these are established two sub-groups, the Larviformia and Fistulata. The former has the disk in its simplest possible form, being composed of five large orals arranged in a pyramid; the second has the ventral side extended into a sac or closed tube often reaching beyond the ends of the arms.

The Camerata are distinguished by the large number of supplementary pieces which bring the proximal arm plates into the calyx, thus enlarging the visceral cavity; all plates are heavy and immovable; the mouth and food grooves are tightly closed.

The Articulata have to some extent the incorporation of the lower arm plates with the calyx, but the plates are movable instead of rigid. The mouth and food grooves are open. The infrabasals are fused with the top stem joint which is not the youngest plate of the stalk. According to whether or not pinnules are present two suborders are recognized: the Pinnata and Impinnata.

An analytical synopsis of the families of Camerata as proposed by the authors and as now understood is as follows:

I. Lower brachials and interbrachials forming an important part of the dorsal cup.

A. INTERRADIALS POORLY DEFINED.

The lower plates of the rays more or less completely separated from the primary interradians by irregular supplementary pieces; dicyclic or monocyclic RETROCRINIDÆ.

B. INTERRADIALS WELL DEFINED.

1. *Dicyclic.*

- a. Radials in contact except at the posterior side THYSANOCRINIDÆ.
- b. Radials separated all around RHODOCRINIDÆ.

2. *Monocyclic.*

- a. Radials in contact all around.
Symmetry of the dorsal cup, if not strictly pentamerous, disturbed by the introduction of anals between the brachials only MELOCRINIDÆ.
Arms borne in compartments formed by partitions attached to tegmen; dorsal cup perfectly pentamerous; plates of calyx limited to a definite number CALYPTOCRINIDÆ.
- b. Radials in contact except at the posterior side, where they are separated by an anal plate.
First anal plate heptagonal, followed by a second between two interbrachials BATOCRINIDÆ.
First anal plate hexagonal, followed by two interbrachials without a second anal, arms branching from two main trunks by alternate bifurcation ACTINOCRINIDÆ.

II. Brachials and interbrachials slightly represented in the dorsal cup.

1. DICYCLIC,

- Radials in contact except at the posterior side CROTALOCRINIDÆ.

2. MONOCYCLIC.

- a. Radials in contact all around; base pentagonal PLATYCRINIDÆ.
- b. Radials separated at posterior side by an anal plate; base hexagonal.
Basals directly followed by the radials HEXACRINIDÆ.
Basals separated from radials by accessory pieces ACROCRINIDÆ.

Regarding the terminology employed, special attention should be called to the clear and concise definitions given of the various structural parts. The terms should be universally adopted, and they form

by far the best collection ever proposed. American writers especially will need no appeal to at once use them, not only in order to secure uniformity in nomenclature but to insure precision of description. Heretofore the names of the various plates or groups of ossicles have been used in a rather haphazard way. Not only have different designations been given to the same part but the same title has been repeatedly applied to structures widely separated morphologically.

CHAS. R. KEYES.

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